ENGINEERING PHASES OF PINK BOLLWORM CONTROL

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1936

The pink bollworm is a major cotton insect pest now found in all cotton producing countries of the world. In areas where the pest has become firmly established damage to the crop is estimated at from 10 to 50 percent. This loss in yield and quality of both cotton seed and lint is caused by the larvae which feed on the lint and the seed kernels within the bolls.

The pest was first discovered in the United States at Hearne, Texas in 1917. This infestation, as well as others in eastern Texas, western Louisiana, the Salt River Valley of Arizona, and isolated sections of western Texas have been eradicated due to persistent and thorough efforts of Federal and State officials. Except for a light infestation in Florida and southern Georgia, where an eradication program is in progress, present known infestation in this country is limited to irrigated sections near the Mexican border where infestation has persisted despite various repressive measures.

Other than the usual regulation of movement of material suspected of harboring a dangerous pest, present eradication and control measures are accomplished by two general methods of procedure: first by the destruction of worms in marketable cotton products or those which are removed from the farm; second, by field cleanup campaigns followed by non-cotton zones or other restrictions as to planting.

The engineering phases of the methods employed for safeguarding marketable cotton products involve measures for the treatment of cotton seed, lint cotton or baled cotton products, and destruction of worms in the waste and trash which accumulates around gins and oil mills. All regulatory measures are enforced by both State and Federal agricultural authorities.

In the infested areas sterilization of all cotton seed as a continuous process of ginning is required. Sterilizers for this purpose consist of specially constructed steam heating boxes and operate either on the live steam or dry heat process. The seed are exposed to a minimum temperature of 145° F. for 30 seconds or longer depending upon the type of sterilizer used. Germination of the seed is not impaired unless the temperature is allowed to exceed 160° F.

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For presentation before the annual meeting of the American Society of Agricultural Engineers, Estes Park, Colo., June 25, 1936.

There are several methods of safeguarding the ginned cotton lint and the regulatory measures required vary with the intensity of infestation in the particular district concerned. The oldest method, and the one still used for disinfecting foreign products at ports of entry, involves vacuum fumigation of the compressed bales with hydro-cyanic acid gas. Sterilization of the bales with live steam at a pressure of 20 pounds for 3 minutes in a specially constructed steam sterilizer was practiced for the past several years in some of the regulated districts of Texas. For treatment of domestic cotton, this, as well as the compression and vacuum fumigation method, have been replaced to considerable extent by the use of a set of smooth crushing rolls through which the lint cotton must pass just before it drops into the bale press box during the ginning process. Maintenance of ample spring tension on the rolls insures the crushing of any worms in the lint cotton.

Pink bollworms in the trash which accumulates around gins and oil mills may be destroyed by burning, steam sterilization or milling. Burning is the surest, simplest and most economical method to use. This requires an incinerator so located as to reduce the fire hazard to adjacent property to a minimum. Sterilization by steam renders the trash free from living pink bollworms. In repeated tests with gin trash heavily infested with pink bollworms it has been shown that passing the material through a hammer type feed mill will destroy the worms and make the material safe for feeding purposes. Regulations regarding gin trash disposal vary somewhat in the various regulated districts.

Although the cotton products which are removed from the farm are properly safeguarded by the foregoing regulatory measures there are large numbers of worms left in that part of the crop which remains in the field.

Because of the continually increasing degree of infestation in the Big Bend Area of western Texas and the potential menace of the pink bollworm to the main cotton belt, a research laboratory was established on the Mexican border at Presidio, in 1928. The field control investigations at this laboratory have been carried out by the Bureau of Entomology and Plant Quarantine and the Bureau of Agricultural Engineering of the U.S.Department of Agriculture in cooperation with the Texas Agricultural Experiment Station. The agricultural engineering work has involved three general classes of investigation. One for the development of mechanical equipment for cleaning the crop remnants from the fields, one for a study of the effectiveness of plowing and irrigation in reducing the pink bollworm population and another for the development of equipment for more efficient application of insecticides.

As the insect spends the winter in the fields in the larval or worm stage this, so far, appears to be the most vulnerable point of attack. The worms are found in the unpicked and immature cotton bolls, in the surface trash, and in the soil. The fact that the worm feeds inside the squares and bolls makes the discovery of practical control measures which can be applied during growth of the crop a difficult

task. It would appear, therefore, that control by destruction of the worms in the crop remnants, surface trash, and in the soil is most logical.

In field cleanup campaigns, the cutting, piling, and burning of the stalks, and collection of the surface trash has been accomplished principally by hand labor due to lack of suitable machinery for the purpose. Mowing machines, cotton stalk cutters, and horse drawn stalk shavers are not efficient due to the rank growth of plants prevalant in irrigated valleys and the excessive shattering of infested bolls from the plants during the cutting process. The Bureau of Agricultural Engineering has developed a push-type shaver for cutting the stalks at ground surface. This apparatus, in principle, is similar to a sled-type shaver except that it is attached to the front of a tractor and is pushed along the ground between two rows of plants. The cut stalks are guided out in windrows to either side of the tractor by shields which prevent the stalks from being passed over by the tractor wheels. This shaver cuts the stalks with a minimum of shattering and being held rigidly in place the heavier stalks do not pass uncut around the ends of the cutting blades.

Collection of the cut stalks into piles for burning cannot be satisfactorily done by ordinary dump or side delivery hay rakes due to the rank plant growth and high irrigation borders. The Bureau of Agricultural Engineering has developed a push rake utilizing the same method of attachment to the tractor as is used for the shaver, which promises to be a practical and efficient rake after further slight alterations. Large readily burnable piles may be collected by the rake. Efficiency of both the shaver and rake would be considerably increased by use of low pressure pneumatic tires on the tractor rather than the lugged steel wheels which tend to bury plant forms in loose sandy soils.

Collection of the bolls which shatter off the plants and other fine leaf particles and surface trash presents quite a difficult and perplexing problem. In the past this material has been collected by hand raking and hand picking which is the largest item in the cost of the field cleanup work. At present an attempt is being made to develop a suction field cleaning device for gathering the debris. Preliminary tests of a small field burner developed at the Toledo shops of the Bureau of Agricultural Engineering for orchard burning work showed that the apparatus was a very effective control weapon for destruction of this surface trash but that the cost of operation so far appeared to be rather excessive. Further investigations may result in a considerable increase in efficiency of the burner.

The various methods discussed so far are aimed at control or destruction of worms in all material above the soil surface. Field population studies conducted by the Bureau of Entomology and Plant Quarantine show that there are large numbers of worms which spend the winter in the soil. Successful control of the European corn borer by clean plowing prompted a study of cultural operations for pink bollworm control. At Presidio, Texas, during the past several years,

a series of experiments have been conducted to determine the killing effect of burial by use of various kinds of plows in different types of soil at different dates and depths of plowing, both with and without irrigation. These tests were conducted on a small plot basis and effectiveness of the various treatments was determined by the number of moths which emerged and were trapped in cages set over the soil of the treated plots. The outstanding results of the four year tests was that most effective control resulted when plowing with complete coverage was followed by an irrigation as soon as possible, or within one week after plowing. At Presidio, plowing prior to February 1 was found to be very bad practice when the application of an irrigation was delayed until just previous to planting time. No experiments have been conducted outside irrigated areas but there is a strong probability that the winter rainfall and lower temperatures of the main cotton belt would increase effectiveness of winter plowing. Increases in depth of plowing resulted in decreases in survival. In general, superior coverage and more effective control were obtained with 14-inch plows than with either 10- and 12-inch plows, or disk plows.

Some of the most promising treatments discovered in the small plot tests mentioned above were also tested on a field basis in which an entire farm was given a specified control treatment. Results were based on the degree of pink bollworm infestation in the crop following treatment. An influx of pink bollworm moths from adjacent untreated areas was believed responsible for failure of these field scale tests to show positive control. This moth migration factor is substantiated by records of the Bureau of Entomology and Plant Quarantine which show that in fields which had not been planted to cotton for several years a damaging worm infestation was recorded in the first crop of cotton to follow such an idle period.

In order to prevent this migration of pink bollworm moths, a three compartment screen wire covered cage, 8 feet in height and covering an area of approximately .77 acre is under construction. This cage will prevent moth migration from nearby untreated fields and it should then be possible to definitely prove or disprove the value of cultural treatments.

In connection with field cleanup measures discussed in preceding paragraphs, discovery of effective cultural control treatment would eliminate the necessity for efficient surface cleaning. At the same time a very high mortality of worms beneath the soil surface would result with little additional expense other than the proper timing of efficient plowing and irrigation.

Preliminary studies are being made of the use of insecticides for control during growth of the crop. Considerable dusting machinery improvement appears necessary before this method of control is proved practical. The eggs are laid in protected places on the plant and the young larvae do very little feeding before they enter the bolls. To be effective, therefore, a poison should be well distributed over all

parts of the plant, and the bolls in particular. A limited amount of work has been done to improve the dust distribution of present commercial dusting machines by providing efficient placement of more dust outlets per row.

No pink bollworms survival was recorded in limited experiments following the use of calcium cyanide or paradichlorobenzene when applied in the open furrow while plowing under infested cotton bolls. The rate at which these chemicals were applied in the tests, however, was too excessive to be practical

In summarizing the engineering phases of present investigations for discovery of effective field control of the pink bollworm consist of the following:

1. Development of mechanical equipment for the destruction of worms in the crop remnants.

2. Determining the value of plowing, irrigation, and other cultural practices as control measures.

The agricultural engineer has opportunity to play a very important part in perfecting methods for the control of the pink bollworm.